RGDSS Memorandum
Final

To: Mike Sullivan, P.E. Colorado Division of Water Resources
Andy Moore, P.E. Colorado Water Conservation Board
From: HRS Water Consultants, Inc.
Eric J. Harmon, P.E., G. Eric Saenger, CPG, Steven K. Barrett
Subject: Hydrogeologic Mapping Review of San Antonio - Ortiz Region
Date: September 6, 2012

INTRODUCTION

This memorandum summarizes the results of a review of hydrogeologic mapping of the San Antonio River valley/Ortiz region of the San Luis Valley modeled area in the RGDSS. This work was done as part of HRS' participation on the Peer Review Team (PRT) to identify and implement improvements to the RGDSS. The study area for this hydrogeologic review included the San Antonio River valley and adjacent areas from approximately the Colorado - New Mexico state line northward to approximately Antonito / U.S. Highway 285 within the RGDSS modeled area. In terms of data review, the study area was defined on the north by the Conejos River, on the south approximately 2 miles south of the New Mexico – Colorado line, and on the east and west by the uplands bordering the San Antonio River valley and the Los Pinos River valley (see Plate 1). This study is adjacent to the south, upstream, along the San Antonio River and the Los Pinos River, of a previous study by HRS whose study area was the valley of the Conejos River and the San Antonio River generally downstream (east) of Highway 285[1].

Modeling results as compared to stream gain/loss and water-level observations in the study area have shown that the valley-wide hydrogeologic mapping done in the earlier phases of the RGDSS was not sufficiently detailed to reflect the complexity of the hydrogeology in this study area. The State and the PRT felt that a better conceptual representation of the hydrogeology was needed than currently exists in the model. Accordingly, HRS was asked to review the available hydrogeologic data and propose improvements to be incorporated in the model.

[1] HRS Water Consultants, Inc., 2012, Hydrogeologic Mapping Review of Conejos / San Antonio Region. RGDSS memorandum, 29p. plus plates and figures.

The primary objectives of this assignment were:

- Determine whether or not a confining layer is present or absent beneath the San Antonio River within the RGDSS model area.
- Recommend any changes to the depth and thickness of the layering of the unconfined aquifer (Layer 1) and the uppermost confined aquifer layer (Layer 2) as represented in the RGDSS model.
- Identify whether perched water tables exist in the study area, because of potential effects on the location of well pumping depletions or recharge accretions.

Other objectives included:

- What is the hydrologic relationship between the surface water flow in the San Antonio River and the underlying aquifer layers?

- What is the general trend of the gradient of the water table in model Layer 1 and deeper aquifer layers in the study area?

No field measurements or testing were done specifically as part of this hydrogeologic evaluation, although HRS did visit the study area in April, 2012, to refresh our understanding of the rock types and stratigraphic relationships. We have relied on published and unpublished public-record geologic and hydrologic data, including work done during previous phases of RGDSS and on visits to the region for past studies.

APPROACH

The majority of the site-specific hydrogeologic interpretations made during this work were based on interpretation of lithology from driller's reports. All of the available logs were researched using the State Engineer's Office (SEO) well permit database. The Rio Grande Water Conservation District water level database was reviewed for water levels and artesian heads in the study area. U.S. Geological Survey and New Mexico Bureau of Geology and Mineral Resources geologic maps and hydrologic reports were consulted. In addition, previous HRS

studies consulted included a hydrogeologic data review of the Conejos and San Antonio River areas for the RGDSS (begun in 2008; completed in June, 2012) and a hydrogeologic data review of the Punche Arroyo subdrainage for Salazar Farms. Hydrogeologic studies by HRS personnel in this general area have been done at various times since approximately 1979.

Well Log Evaluations

All well logs were downloaded from the SEO's website using the site's Well Permit Search Tool http://www.dwr.state.co.us/WellPermitSearch/default.aspx. Only wells with a driller's log were selected. HRS hydrogeologists reviewed each driller's log to arrive at our interpretation of the hydrogeologic features of interest to this evaluation.

Hydrostratigraphy and Aquifer Layers

This hydrogeologic review has confirmed the general stratigraphy of the aquifer layering as previously represented in the RGDSS, but has provided refinement of the depth, thickness, and aquifer materials that comprise aquifer Layers 1, 2, 3, and 4. No wells are sufficiently deep to determine whether Layer 5 exists in the study area. Our best estimate based on regional geophysics is that Layer 5 is unlikely to exist in this area, although at this time data is not sufficient to answer this question. Until such time as the deep well and geophysical database improves, we have chosen not to include Layer 5 in this study area.

The formations that comprise the aquifers, and the physical characteristics of the aquifer layers in the study area, are shown in Table 1.

Table 1 Hydrostratigraphy of the Conejos River valley and San Antonio River valley study area					
		Conejos River Subwatershed	La Jara Creek / Alamosa River Subwatershed	San Antonio River Subwatershed	Punche Arroyo Subwatershed (northern Taos Plateau)
Layer 1	*Formation*	Quaternary alluvium and glacial outwash. Holocene deposits in present river bottoms. Colluvium and landslide deposits along steep hillsides.	Quaternary alluvium and glacial outwash. Holocene deposits in present river bottoms. Colluvium and landslide deposits along steep hillsides.	Quaternary alluvium and glacial outwash. Holocene deposits in present river bottoms.	Quaternary alluvium and glacial outwash. Holocene deposits in present river bottoms. Not present south of T32N - T33N line.
	Lithology	Poorly stratified silt, sand, gravel in valley bottoms. Clay lenses present in most areas.	Poorly stratified silt, sand, gravel in valley bottoms. Clay lenses present in most areas.	Poorly stratified silt, sand, gravel in valley bottoms. Clay lenses present in most areas.	Poorly stratified silt, sand, gravel in valley bottoms. Clay lenses present in most areas.
	Thickness	20 to 60 feet. Generally thinning from west to east.	20 to 60 feet. Generally thinning from west to east.	20 to 50 feet in San Antonio valley bottom.	0 to 40 feet
	Type of Aquifer	Unconfined	Unconfined	Unconfined. Perched water table generally south of T33N - T34N line.	Unconfined, perched water table where the aquifer exists. Does not exist generally south of T32N - T33N line.
Layer 2	*Formation*	Older alluvium (Pleistocene - Pliocene?) grading into Alamosa Formation confining clays to the north.	Alamosa Formation confining clay series	Older alluvium (Pleistocene - Pliocene?). Servilleta Fm. In southern part.	Servilleta Formation (Pliocene)
	Lithology	silt, sand, gravel terrace and fan deposits; poor to fair stratification; uppermost clay forms an aquitard. Some clay in discontinouous lenses deeper. Grades into Alamosa Fm. 'blue clay' series north of Manassa.	silt, sand, gravel terrace and fan deposits; poor to fair stratification; some clay in discontinouous lenses. Grades into Alamosa Fm. 'blue clay' series north of Manassa.	silt, sand, gravel terrace and fan deposits; poor to fair stratification; uppermost clay forms an aquitard. Servilleta basalt lava flows may be present beneath San Antonio River in some parts of this area.	Fractured to non-fractured olivine basalt lava flows, interlayered with sediments. Where unfractured, lava forms an aquitard along with clay layers on top of, and between, lava flows.
	Thickness	20 to 200 feet. Generally thicker in central study area; thins to east and west.	20 to 300+ feet. Generally thickens to the north; thins south, east and west.	20 to 150 feet. Thickens to the south.	20 to 200 feet. Thickens to the south.
	Type of Aquifer	Confined	Confined	Confined (N.) to Unconfined (S.)	Unconfined
Layer 3	*Formation*	Hinsdale / Los Pinos interbeds (Oligocene)	Hinsdale / Los Pinos interbeds (Oligocene)	Hinsdale / Los Pinos interbeds (Oligocene) and Servilleta Fm. (south)	Servilleta Formation (Pliocene) or Hinsdale / Los Pinos interbeds (where present)
	Lithology	Fractured to unfractured basalt lava flows sourced from vents at Los Mogotes. Enhanced permeability where fractured. Lava flows are interbedded with Los Pinos Fm sediments; thickest in central study area.	Fractured to unfractured basalt lava flows sourced from vents at Los Mogotes. Enhanced permeability where fractured. Lava flows are interbedded with Los Pinos Fm sediments; thickest in central study area.	Fractured to unfractured Hinsdale basalt lava flows sourced from vents at Los Mogotes. Interfingers with Los Pinos Fm sediments.	Fractured to non-fractured olivine basalt lava flows, interlayered with sediments. Where unfractured, lava forms an aquitard along with clay layers on top of, and between, lava flows.
	Thickness	20 to 200+ feet. Generally thicker in central study area; thins to east and west.	20 to 200+ feet. Generally thicker in central study area; thins to east and west.	20 to 200+ feet. Hinsdale pinches out to south; Servilleta thickens to south.	20 to 200 feet. Thickens to the south.
	Type of Aquifer	Confined	Confined	Confined (N.) to Unconfined (S.)	Probably unconfined; may be confined in some areas.
Layer 4	*Formation*	Conejos Formation	Conejos Formation	Conejos Formation	Conejos Formation
	Lithology	Lava flows, flow breccias, lahar, ash fall, and similar deposits interbedded with poorly-indurated mostly fine-grained volcaniclastic deposits. Layer 4 may inlcude some deeper, mostly fine-grained sandstones and mudstones of the Santa Fe Fm in this area.	Lava flows, flow breccias, lahar, ash fall, and similar deposits interbedded with poorly-indurated mostly fine-grained volcaniclastic deposits. Layer 4 may inlcude some deeper, mostly fine-grained sandstones and mudstones of the Santa Fe Fm in this area.	Lava flows, flow breccias, lahar, ash fall, and similar deposits interbedded with poorly-indurated mostly fine-grained volcaniclastic deposits. Layer 4 may inlcude some deeper, mostly fine-grained sandstones and mudstones of the Santa Fe Fm in this area.	Lava flows, flow breccias, lahar, ash fall, and similar deposits interbedded with poorly-indurated mostly fine-grained volcaniclastic deposits. Layer 4 may inlcude some deeper, mostly fine-grained sandstones and mudstones of the Santa Fe Fm in this area.
	Thickness	200 to 1,500+ feet. Generally thought to be thicker in central study area; thinner to east and west based on regional geophysics.	200 to 1,500+ feet. Generally thought to be thicker in central study area; thinner to east and west based on regional geophysics.	200 to 1,000+ feet. Little data available on this formation.	200 to 1,000+ feet. Little data available on this formation.
	Type of Aquifer	Confined	Confined	Confined	Confined
Note: Based on regional geophysics, Layer 5 is unlikely to exist in this area. No wells penetrate sufficiently deep to define this layer in the Conejos / San Antonio study area.					

As described in Table 1, the hydrogeology of the aquifers in the study area is quite complex. Note that the La Jara Creek / Alamosa River subwatershed is not in the study area of this review. It is part of the study area of the Conejos River – San Antonio River valleys, which adjoins the study area of this review on the North[2]. Notable features of the aquifer layers in the study area are as follows:

[2] Ibid.

- The unconfined aquifer (model Layer 1) in the majority of the study area generally thickens and is more gravelly to the west and north toward the Conejos River and becomes thinner and less gravelly underlying the San Antonio River.
- Ground water recharges to the unconfined (and also the confined) aquifer in the study area by deep percolation from precipitation, stream losses, and most likely also from ditch losses and irrigation returns.
- Clay is noted in some, although not all, of the available well logs at and near the bottom of the near-surface Layer 1 alluvium and glacial outwash deposits underlying the San Antonio River, and well logs indicate the presence of a shallow water table (generally 20 feet or less) and, in some areas, a deeper water table (generally at least 100 feet deep). From this, we conclude that an aquitard layer exists in some areas that underlie the San Antonio River that restricts the downward movement of water.
- Layer 2 in the study area, with the exception of the entirety of the Punche Arroyo subwatershed, is comprised of lower permeability layers of "older" sediments (i.e. pre-Pleistocene) and possibly also the upper part of the Los Pinos Formation, as compared to higher permeability alluvial sand and gravel that is predominant in Layer 1. In the Punche Arroyo subwatershed Layer 2 is composed of Servilleta Formation basalt lava flows and thin sedimentary interbeds (see Table 1).
- The Hinsdale basalt lava flows and interbedded sediments of the Los Pinos Formation (generally considered part of the Santa Fe group of formations) comprise Layer 3 in the study area. Where the basalt flows are unfractured their permeability is relatively low. Where fractured the basalt lava flows form a highly permeable aquifer.
- The bottom portion of the Los Pinos / Santa Fe Formation sediments, which lie below the oldest Hinsdale basalts, along with the yet deeper Conejos Formation volcanic and volcaniclastic sediments below the Santa Fe Formation, comprise Layer 4.
- In some areas, particularly near the village of San Antonio, the water table in Layer 1 appears to be perched above a deeper water table that exists within the Los Pinos Formation or within Hinsdale Formation basaltic lava flows where the latter are present. Perched water tables, and an unsaturated zone between Layer 1 and Layer 2, do not appear to exist throughout the study area.

- To the east of approximately Highway 285, the deeper water table is within the Servilleta Formation. The Servilleta Formation extends to the east and south along the east edge of the San Antonio River. Basalt lava flows of the Servilleta Formation are seen to overlie the Hinsdale Formation in the area of Sections 8, 17 and 18, T32N, R9E along the east edge of the San Antonio River valley[3] (east of the village of San Antonio).
- The deeper water table seen in T32N, R8E to R10E (San Antonio River valley and the Punche Arroyo subwatershed) generally coincides with, and may be a result of, the presence of the Servilleta Formation, which is not seen to extend to the west or north of the San Antonio River. The water table in the Servilleta (model Layers 2 and 3 where this formation exists) is generally on the order of 100 or more feet deep, appears to be unconfined, and has a gradient to the south and east away from the San Antonio River. The water table in the Hinsdale/Santa Fe/Los Pinos formations appears to be confined to the west, and has a gradient to the east-southeast of approximately 0.014 ft/ft.
- The water table in Layer 1, the alluvium of the San Antonio River, has a gradient that is generally parallel to the direction of flow of the San Antonio River.
- Aquifer Layer 1 does not exist in the area east of Highway 285 and south of a line generally from zero to 1.5 miles south of County Road E.5, between Highway 285 on the west and the Pinon Hills (southern part of the San Luis Hills) on the east. In this area, lava flows of the Servilleta Formation exist at the surface or just below surface soils. Alluvium of the San Antonio River or Punche Arroyo either was never deposited in this area or has been eroded away.

Clay Extent Underlying the San Antonio River

In order to investigate the existence and lateral extent of clay layers underlying the San Antonio River, HRS constructed several geologic cross sections. Cross section F-F' was constructed for a hydrogeologic review of the area of the Conejos and San Antonio River valleys adjacent to this

[3] Lipman, Peter W., 1975, Geologic Map of the Lower Conejos River Canyon Area, Southeastern San Juan Mountains, Colorado, US Geological Survey Miscellaneous Investigations Series Map I-901

study area on the north, but proved useful for this evaluation as well[4]. Cross sections G-G', H-H', and I-I', constructed for this review, are located approximately transverse to the San Antonio River where lithologic logs existed for wells on either side of the river. A fifth cross section, J-J', was constructed approximately parallel and coincident with the San Antonio River (as well locations would allow). The locations of the cross sections, labeled F-F' to J-J' (going from north to south) are shown on Plate 1 with the wells used in the construction of each cross section highlighted. The ground level elevations used for the sections were estimated from USGS 1:24,000-scale topographic maps.

Cross section F-F' (see Figure 1; see Plate 1 for location) is located approximately parallel to CR E.5 from Highway 285 eastward. From Highway 285 the section goes northwest approximately 2.5 miles crossing the San Antonio River and then approximately paralleling the Conejos River on the south. The section traverses from west to east in the following sections: Section 36, T33N, R8E; Sections 31 to 36, T33N; and Section 31, T33N, R10E. The west end shows the Conejos River alluvium having minor thin clay lenses. The alluvium overlies the Santa Fe/Los Pinos Formation. Well Permit 224964 shows the deeper confined water level of Layer 3 within the basalts. The bluff on the east edge of the San Antonio River valley is the western edge of the Servilleta Formation volcanic rocks. Wells from this point eastward show the deeper Layer 2 / Layer 3 water level within the Servilleta lava flows or interbedded alluvial material between the lava flows. Two Rio Grande Water Conservation District monitoring wells, Permits 230639 and 23058, show the Layer 1 unconfined water table.

Cross section G-G' (Figure 2) is located approximately one mile south of section F-F' in Section 6, T32N, R8E, Sections 5 and 7, T32N, R9E, and Section 32, T33N, R9E (west to east). This section shows the Santa Fe/Los Pinos Formation outcrop at the west end. To the east Holocene deposits consisting primarily of sand and gravel alluvium, overlies the Santa Fe/Los Pinos Formation sand and gravel and clays. Driller's logs were not precise enough to differentiate between the overlying unconsolidated alluvium and the underlying Los Pinos poorly-indurated sandstone, ash beds, and conglomerate, these interpreted depths were based on our observations of the geology, and interpretations of the driller's logs. Also shown are the volcanic rocks of the

[4] HRS Water Consultants, Inc., 2012, Hydrogeologic Mapping Review of Conejos / San Antonio Region. RGDSS memorandum, 29p. plus plates and figures.

Hinsdale Formation. The Servilleta Formation volcanic rocks are shown east of the river overlying the Hinsdale Formation. The water table in the recent alluvium is shown for well Permit no. 145917 (next to the river). This well had no reported clay intervals. The rest of the wells show the deeper Layer 3 water level. In well Permit 37857, the Layer 3 static water level, in conjunction with the completion interval and first reported water in the Hinsdale, indicates that at this location Layer 3 (and probably also the underlying Layer 4) are under confined conditions.

Cross section H-H' (Figure 3) is located approximately 1.5 southwest of cross section G-G', in Sections 26 and 27, T35N, R10E. As with section G-G', this section shows the recent sand and gravel alluvium overlying the Santa Fe/Los Pinos sand/sandstone and gravel/sandstone and gravel or sand and gravel conglomerate. The two wells on the east end of the cross section, permits 254624 and 107605 (dry hole), show the variability between drillers of the descriptions of the materials penetrated. These two wells are only 320 feet apart.

Cross section I-I' (Figure 4) is located approximately two miles south of cross section H-H' in the Ortiz area in Sections 13 and 24, T32N, R8E. This section shows more clay in the recent sand and gravel alluvium overlying what we interpret to be relatively clay-rich Santa Fe/Los Pinos alluvium. The Hinsdale Formation volcanic rocks were penetrated in one well, Permit 138744-A. The only water level reported is in the Holocene alluvium associated with recent deposition by the Los Pinos River and the San Antonio River.

Cross section J-J' (see Figure 5), is the southwest to northeast section that ties section G-G' through I-I' together. This section shows that the Holocene alluvium thins to the northeast to the narrow point (water gap or constriction) in the valley just south of San Antonio (see Plate 1). This valley constriction is caused by a lava flow or flows of the Hinsdale basalt through which the San Antonio River appears to have cut the present river channel. Based on well Permit No. 228758 (on the east side of the river at a narrow constriction in the river valley) HRS believes it is likely that the San Antonio River is flowing on the basalt lava rock, or on a very thin alluvial cover on top of the basalt lava rock, in this area. To the north of the valley constriction the Holocene alluvium thickens to the north toward the Conejos River valley. A number of wells penetrated into the Hinsdale volcanic rocks near their total reported depths. None of these wells record any water within the volcanic rocks. Based upon the thick clay layers penetrated in

several wells and the presence of the volcanic rocks penetrated, we believe the Holocene alluvium overlies the Santa Fe/Los Pinos Formation or Hinsdale basalt lava rock. As discussed previously, the driller's descriptions are seldom sufficiently detailed to distinguish between the Holocene or earlier Quaternary alluvium, from the sediments of the Tertiary Santa Fe/Los Pinos Formation. Well Permit No. 139004-A was screened in what we interpret to be Santa Fe/Los Pinos, as the completed static water level, at 38 feet depth, is much deeper than the first reported water at 4 feet.

In summary, based upon our review of the driller's log data and construction of cross sections F-F' through J-J', the northern part of the study area has two distinct water tables in the vicinity of the San Antonio River:

- A perched water table within the recent alluvium, that appears to be caused by a lower permeability zone either due to a basal clay-rich deposit within the Quaternary alluvium, or a clay-rich stratum within the upper part of the Santa Fe/Los Pinos Formation and or Hinsdale basalt layers.
- A deeper water table also exists within the Santa Fe/Los Pinos Formation and the Hinsdale Formation with which the Los Pinos sediments are interbedded.
- Some areas of the upper San Antonio River valley, notably the area near the valley constriction south of the village of San Antonio, do not exhibit a perched water table. Instead, there appears to be no unsaturated zone between Layer 1 and the deeper aquifer layers.

A well, Permit No. 34869, to the southwest of the valley constriction located in the NW/4 SW/4 Section 18, T32N, R9E was drilled to a total depth of 304 feet. Volcanic rock was penetrated from 200 to 304 feet. The first water was reported in the interval from 270 to 304 feet. The static water level was reported at 260 feet. This is the only indication of a deeper water table in this area.

San Antonio River from the State Line to Highway 285

In the area south (upstream) of the bridge at U.S. Highway 285, about one mile south of Antonito, the San Antonio River traverses volcanic rocks of the Servilleta Formation. This is in the area encompassed by Section 18, T32N, R9E and Section 32, T33N, R9E. Also in this area some of the well data show two distinct water tables: a shallow water table associated with the river and near surface alluvial deposits in which the gradient is approximately parallel with the river, and a deeper water table within the Hinsdale Formation, Los Pinos sediments, or the Servilleta Formation basalt lava flows and interbedded alluvial material, in which the gradient is southeast toward the Taos Plateau. The cross section upstream to downstream along the San Antonio River (J-J'), however, does not show a perched water table in all areas.

The deeper "confined" aquifer layers (Layers 2 and 3) appear to be unconfined in the area southeast of Antonito, but transition to a confined aquifer as one progresses westward to the upland west of the San Antonio River valley near the village of San Antonio. The water in the San Antonio River and the near-surface alluvium is perched on top of the shallow clay layers or, in some areas, on top of the shallow-lying Hinsdale Formation volcanic rock or the interbedded Los Pinos sedimentary rocks. As discussed in the HRS memorandum on the Conejos / San Antonio area hydrogeologic review[5], the available driller's logs show that this perched aquifer system persists downstream along the San Antonio River for several miles. The two water tables are separated by an unsaturated zone in an area that appears to coincide with the presence of the Santa Fe/Los Pinos sediments to the west to relatively shallow basalt lava rock layers of the Servilleta Formation in the subsurface to the east. Further downstream, the perching appears to be a result of relatively thin clay layers that underlie the riverbeds.

Conclusions

1. Clay or relatively low permeability Santa Fe/Los Pinos Formation material are present beneath the San Antonio River in the majority of the study area, and appears to form an aquitard layer. The clay or low permeability Santa Fe/Los Pinos Formation material,

[5] Ibid.

based on the logs available, appears to form the base of Layer 1 or the uppermost stratum of the confined aquifer (Layer 2).

2. A perched water table is seen in some areas but not the entirety of the study area. Cross section J-J' (Figure 5), upstream to downstream along the San Antonio River, shows continuous saturation between Layer 1 and the deeper aquifer layers, particularly to the south of the valley constriction just south of the village of San Antonio.
3. Near-surface water-saturated sediments in Layer 1 in this study area show a water table generally within 5 to 20 feet of ground surface, and a gradient generally parallel to the direction of flow in the Los Pinos River and the San Antonio River.
4. In the area to the south of the valley constriction (just south of the village of San Antonio) a deeper water table not in connection with the shallower water table may exist but due the lack of deeper drilling and well completion cannot be demonstrated at this time.
5. A deeper water table seen in the volcanic rocks of the Servilleta Formation and the Hinsdale Formation, and the Los Pinos sediments with which the Hinsdale is interbedded. In some areas (e.g. cross section G-G'; see Figure 2) the water table generally is at least 100 feet deep. This deeper water table shows a water table gradient toward the east or southeast, toward the Taos Plateau.

Recommendations

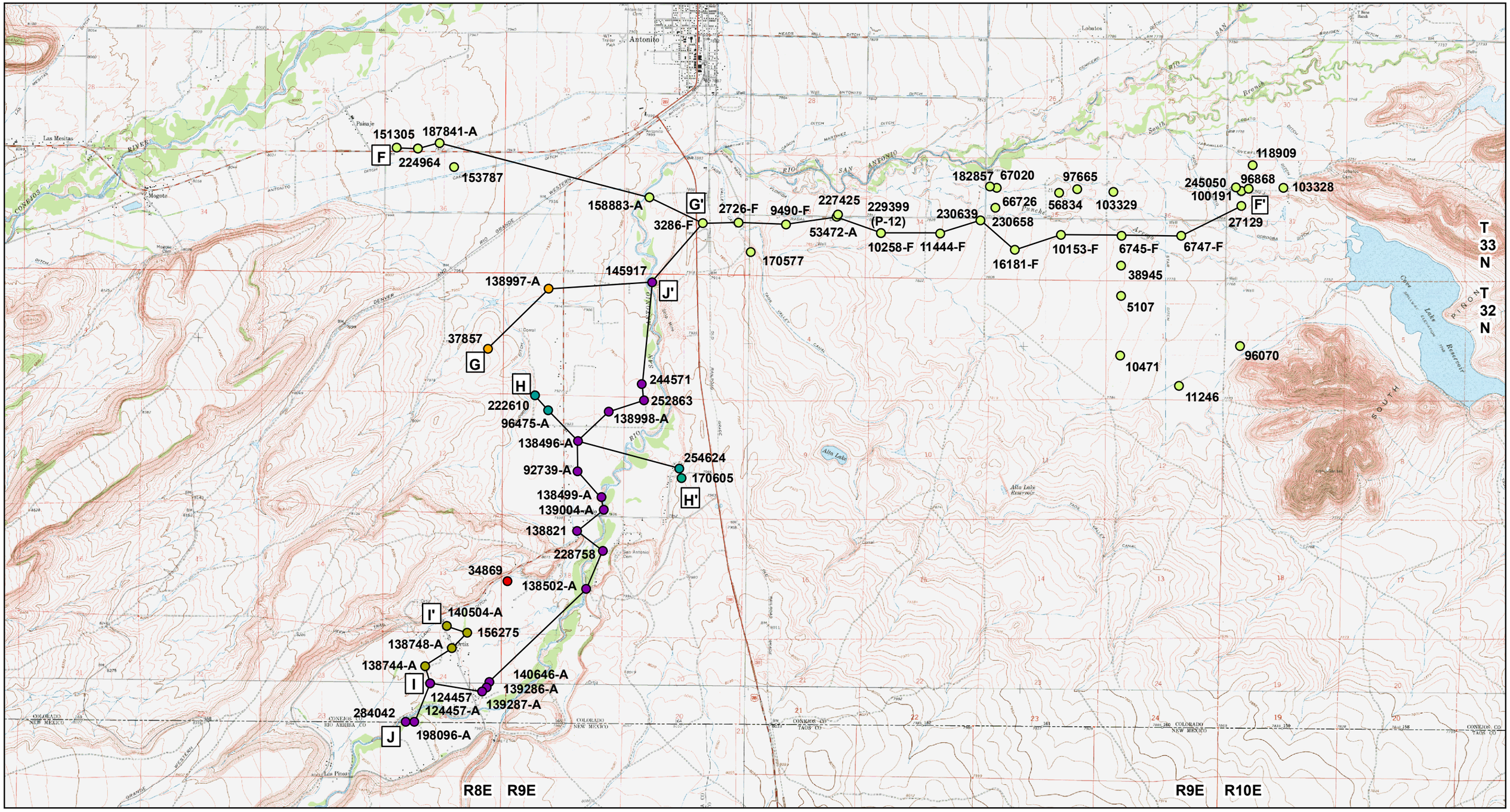
From this review of hydrogeologic data in the San Antonio River/Ortiz study area, we make the following recommendations to the RGDSS for modeling revisions.

1. The relatively continuous aquitard at the bottom of Layer 1 or the top of Layer 2 should be represented in the RGDSS model as a relatively low vertical hydraulic conductivity (Kv) between Layer 1 and Layer 2, or a lower K in Layer 2 than in Layer 1.
2. The San Antonio River where water-table perching is observed should be represented in the RGDSS model as a relatively low Kv between Layer 1 and Layer 2, and a relatively high Kh in Layer 2, so that the unsaturated zone between these layers will be represented in the model.

3. Layer 1 thickness in the San Antonio River valley generally varies from 20 to approximately 60 feet thick, although a few areas up to 80 or more feet thick are seen. Layer 2 also is variable, and is generally from 20 to over 100 feet thick in the study area.
4. Layer 1 should be omitted from the model altogether in the southernmost area of the model in Conejos County where the Servilleta Formation lava flows exist at the surface, and there is no alluvium present.

Comments and Concerns

As discussed previously, HRS has researched and reviewed all of the available well driller lithologic logs from the SEO well database to determine depths to the following: water table and reported clay. The quality of the lithologic descriptions varied greatly from quite detailed to very general. Most logs were of good enough quality for the purposes of this investigation, although there is noticeable variation in lithologic descriptions between drillers, even in wells that are close together as described above for well Permit Nos. 254624 and 107605. The conclusions formed from this study may be modified as more data becomes available in the future.



Legend

- F-F' Wells
- G-G' Wells
- H-H' Wells
- I-I' Wells
- J-J' Wells
- Well 34869

1 inch = 4,000 feet

0 0.5 1 2 Miles

RGDSS

Plate 1 - Ortiz Area Cross-Sections Location Map

HRS Water Consultants, Inc.

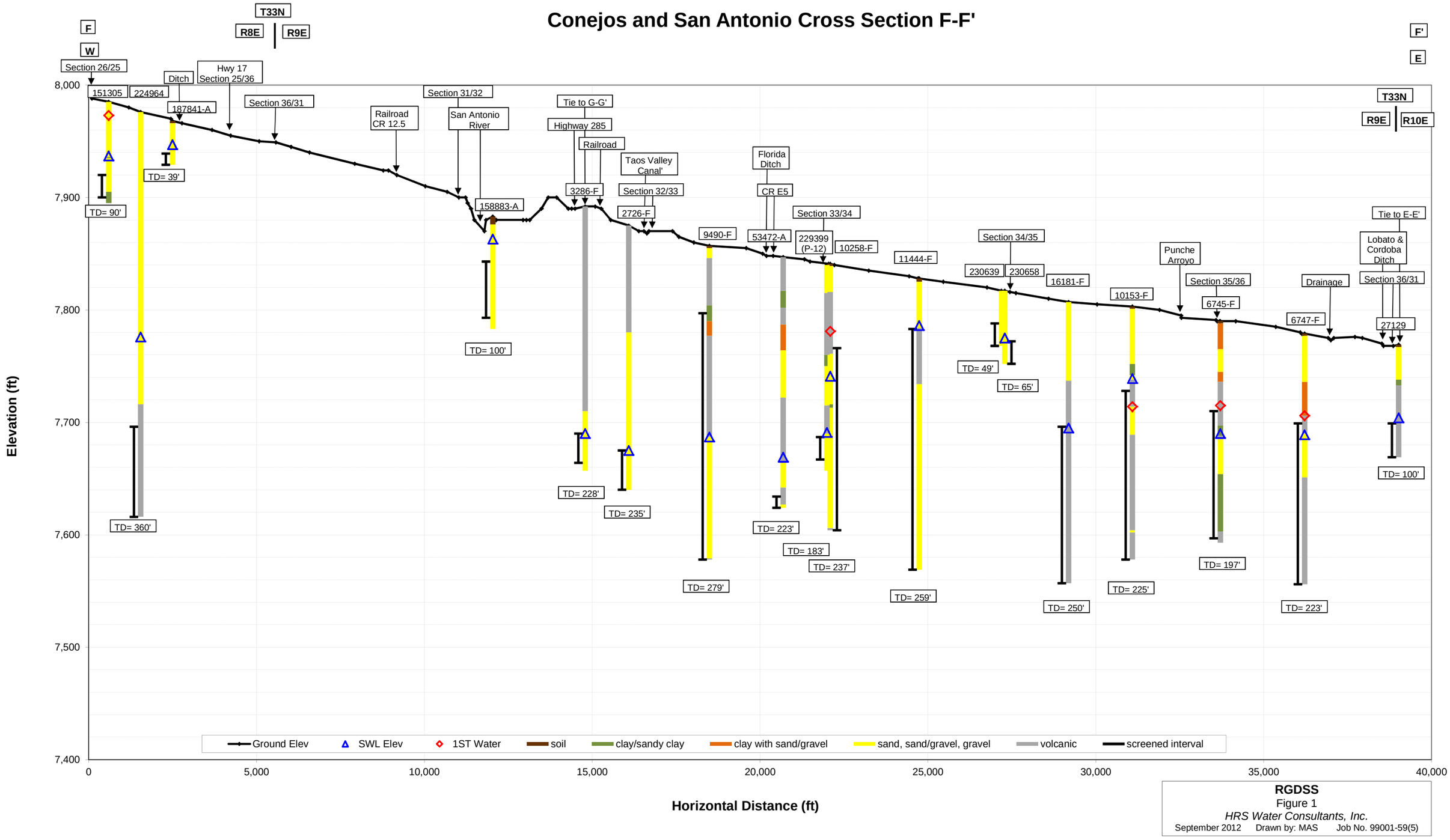
September 2012

Drawn By: MAS

Job No. 99001-59

Ortiz_area_cross_sections.mxd

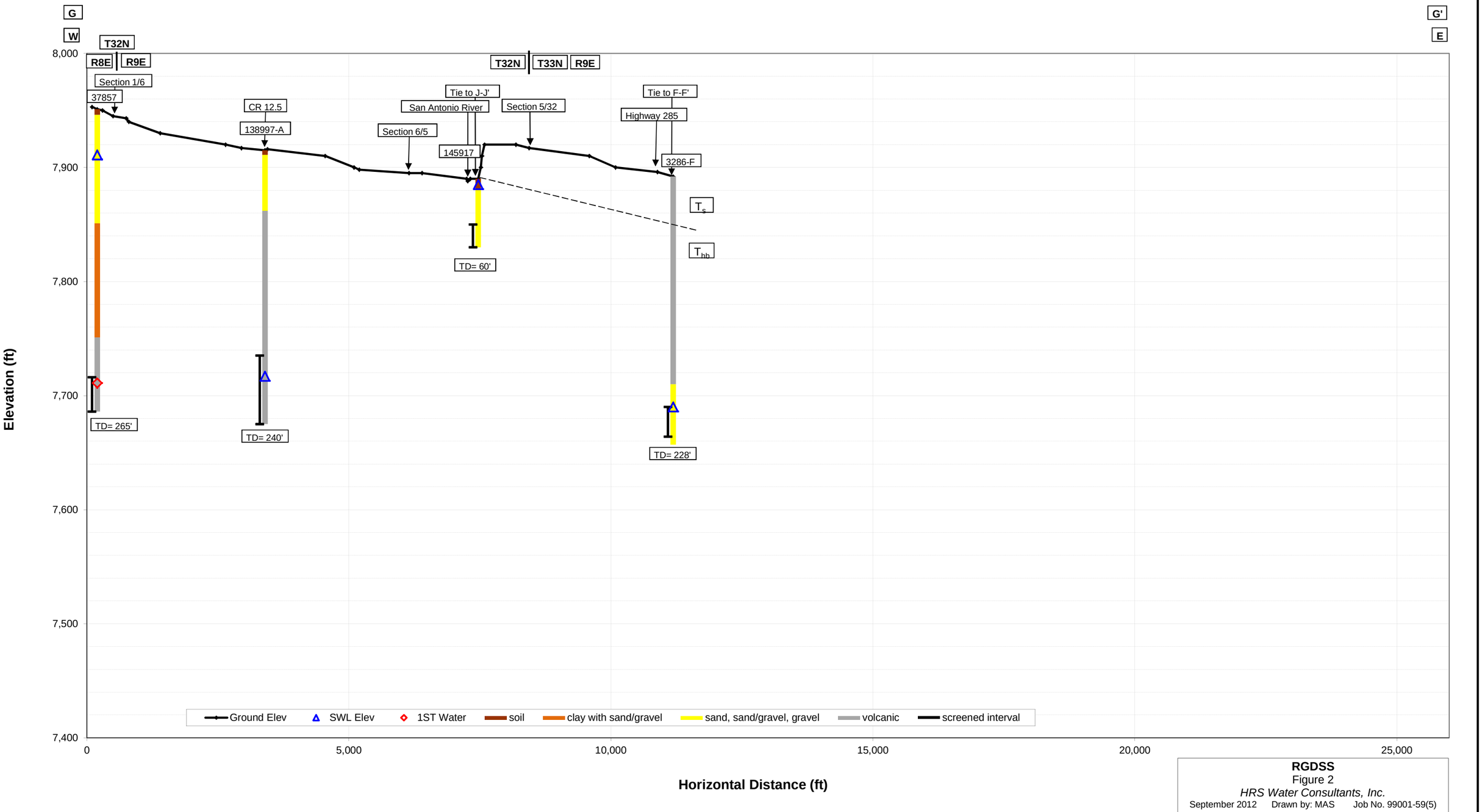
Conejos and San Antonio Cross Section F-F'



RGDSS
Figure 1
HRS Water Consultants, Inc.
September 2012 Drawn by: MAS Job No. 99001-59(5)

I:\Marielle Sidell\Clients\RDGSS\Cross Sections\Conejos and San Antonio\Conejos and San Antonio - F-F'.xlsx

San Antonio-Ortiz Cross Section G-G'



RGDSS
Figure 2
HRS Water Consultants, Inc.
September 2012 Drawn by: MAS Job No. 99001-59(5)

I:\Marielle Sidell\Clients\RDGSS\Cross Sections\Conejos and San Antonio\Conejos and San Antonio - G-G'.xlsx

San Antonio-Ortiz Cross Section H-H'

H

W

H'

E

T32N R9E

222610

96475-A

Tie to J-J'

138496-A

San Antonio River

Section 7/8

254624

107605
(Dry Hole)

T_{hb}

T_s

Q_{al}

T_{hb}

TD = 48'

?

?

?

?

TD = 105'

$T_{sf/lp}$

T_{hb}

TD = 260'

TD = 280'

TD = 300'

Elevation (ft)

8,000
7,900
7,800
7,700
7,600
7,500
7,400

0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000

Horizontal Distance (ft)

Ground Elev | SWL Elev | 1ST Water | soil | clay/sandy clay | clay with sand/gravel | sand, sand/gravel, gravel | volcanic | screened interval

RGDSS
Figure 3
HRS Water Consultants, Inc.
September 2012 Drawn by: MAS Job No. 99001-59(5)

I:\Marielle Sidell\Clients\RDGSS\Cross Sections\Conejos and San Antonio\Conejos and San Antonio - H-H'.xlsx

San Antonio-Ortiz Cross Section I-I'

I

S

I'

N

T32N R8E

Tie to J-J'

124457

124457-A

138744-A

138748-A

Section 24/13

156275

140504-A

Q_{al}

Q_{al}

$T_{sf/lp}$

$T_{sf/lp}$

T_{hb}

TD = 69'

TD = 80'

TD = 75'

TD = 79'

TD = 120'

1982 SWL = 15'
1993 SWL = 40'

Ground Elev | SWL Elev | 1ST Water | soil | clay/sandy clay | clay with sand/gravel | sand, sand/gravel, gravel | volcanic | screened interval

Elevation (ft)

8,200
8,100
8,000
7,900
7,800
7,700
7,600

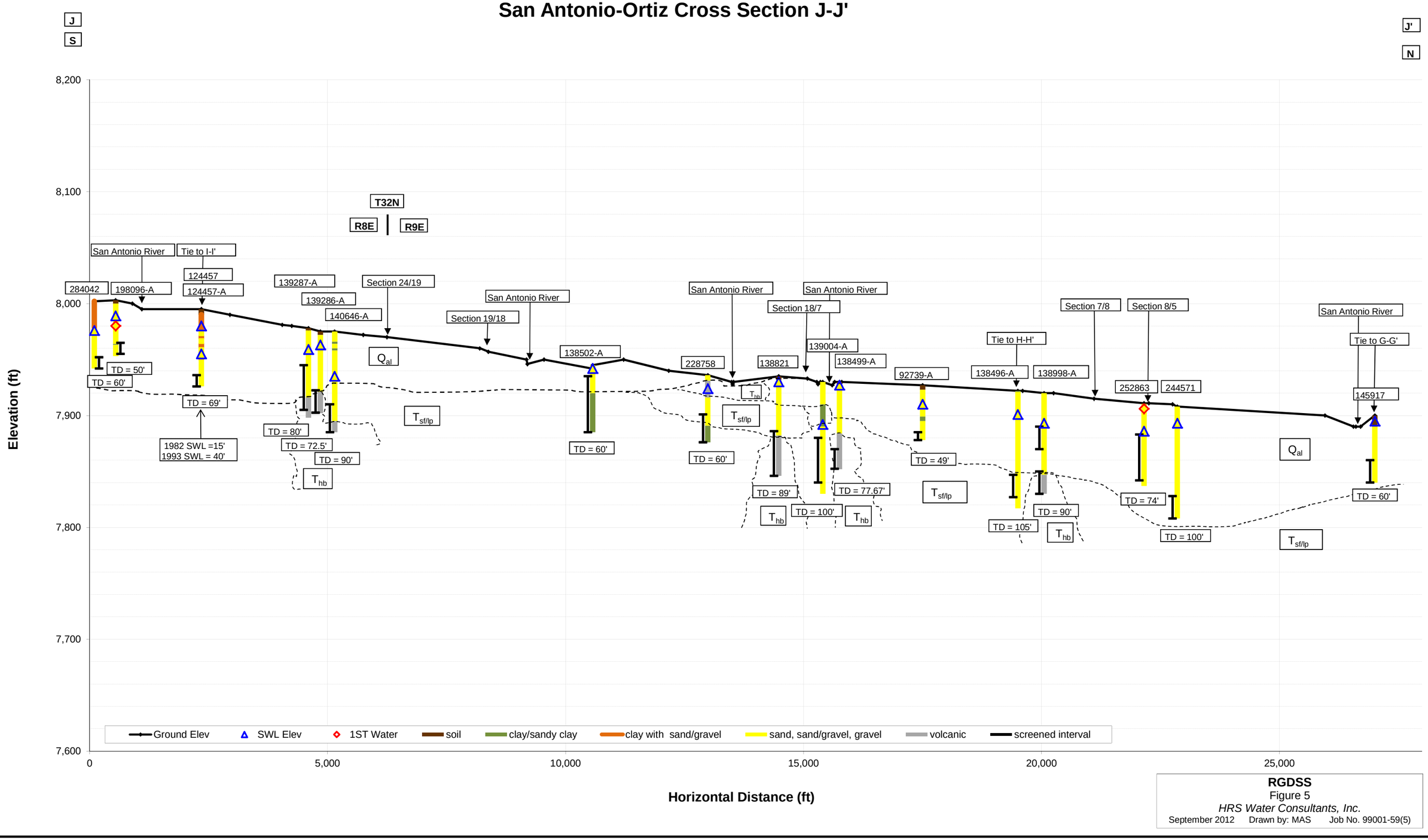
0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000

Horizontal Distance (ft)

RGDSS
Figure 4
HRS Water Consultants, Inc.
September 2012 Drawn by: MAS Job No. 99001-59(5)

I:\Marielle Sidell\Clients\RDGSS\Cross Sections\Conejos and San Antonio\Conejos and San Antonio - I-I'.xlsx

San Antonio-Ortiz Cross Section J-J'



RGDSS
Figure 5
HRS Water Consultants, Inc.
September 2012 Drawn by: MAS Job No. 99001-59(5)

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